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ABSTRACT

There are at least two kinds of phonetic knowledge: phoneme synthesis and analytic knowledge. In phoneme synthesis a person demonstrates phonetic knowledge by being able to assemble segments into larger units. With analytic knowledge one knows that syllables or words are analyzable into constituent segments. One type of knowledge enables learning to read and the other type follows from learning to read. These issues were the background for a longitudinal study carried out with 99 beginning readers. In the study, children were tested at four points throughout the school year. At each point children were tested on three phonetic tasks, a test of simple sentence-reading, and a test of pseudoword reading. The two phonetic tasks of main interest were a test of phoneme synthesis and a test of phoneme deletion. Of central interest was the relationship between the child's reading ability and his or her performance on these tasks. From this study it was concluded that regardless of instructional method, phoneme synthesis ability was necessary for reading to occur, but it was not sufficient. Phoneme deletion was sufficient for reading to occur but not necessary. Thus, the ability of phoneme analysis is one that is followed by early skills in reading, whereas the ability of phoneme synthesis is one that precedes early skills in reading. This suggests that the relationship between phonetic knowledge and early reading is one of mutual facilitation based on the intimate relationship between spoken and written language. (HOD)

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Learning to Read Depends on Phonetic Knowledge and Vice-Versa

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Learning to Read Depends on Phonetic Knowledge and Vice-Versa

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We have always thought that the idea that phonetic knowledge had something to do with reading was an important and interesting one. The early observations by Isabelle Liberman and Don Shankweiler, as well as those by Matingly and by Rozin & Gleitman, were important in pointing out the possibilities for such a relationship. The arguments for why phonetic knowledge may be important for reading do not have to be repeated here. Instead, what we want to do is to suggest that the relationship between phonetic knowledge and learning to read runs in both directions. Thus the title of our presentation is to be taken at face value. To elaborate this suggestion, we will first argue that there is more than one kind of phonetic knowledge. We will refer then to the results of a longitudinal study of first grade reading to support this claim. And third, we will link observations on these kinds of phonetic knowledge to reading achievement.

At Least Two Kinds of Phonetic Knowledge

One basic type of phonetic knowledge is what we call phoneme synthesis. This kind of knowledge underlies what people refer to as "blending." In phoneme synthesis a person demonstrates phonetic knowledge by being able to assemble segments into larger units. For example, the three segments K t can be synthesized to produce the word cat. More generally, three segments can be synthesized to produce a syllable. A child who can really perform phoneme synthesis is a good candidate to benefit from reading instruction. The reason is that learning to read words requires synthesizing letters or synthesizing

phoneme sequences that correspond to letters. However, we cannot say that such knowledge is a strong prerequisite to beginning reading. Learning to read can begin by associations between grapheme patterns and word names that do not depend on synthesis of constituents. However, we would suggest that at the point where real reading begins as opposed to just holistic word recognition, then phoneme synthesis is going to be important. It certainly is important in reading words not seen before and in reading non-words.

The second kind of phonetic knowledge that we have in mind is a more analytic kind. Basically it is knowledge than syllables or words are analyzable into constituent segments. For example the knowledge that CAT has fewer phonemes than SCAT is analytic knowledge. The question of how to tap this knowledge is an important issue. But however it is measured it is knowledge of a very different kind from phonetic synthesis. It represents a far more sophisticated explicit knowledge. That means its relation to reading, by our account, is a little bit different. A child does not have to have analytic knowledge of phonemes in order to learn to read.

We think an important development in learning to read has sometimes been overlooked. Learning to read affects general language processes. One such effect is that learning to read produces a knowledge of phonemes that would otherwise be lacking. We might also imagine that learning to read has corresponding effects on other linguistic knowledge such as syntax and of morphology. The reason for this assumption is that learning to read forces a child to attend to things that have never before come to consciousness. All the constituent parts of language structure are hidden from the child's awareness prior to learning to read. The ability to manipulate and really use the structure of

language is partly brought about by beginning to read. Analytic phonetic knowledge is one example.

The Perfetti, Beck, and Hughes Longitudinal Study

These issues were the background for longitudinal study carried out with 99 beginning readers. Some of the results of this study were reported at the 1981 SRCD meeting. What we will do today is refer to some of the results of this study to support our claim that one type of knowledge enables learning to read and the other type of knowledge follows from learning to read.

In the longitudinal study children were tested at four points through the school year from earlier September to late April. At each test point children were tested on three phonetic tasks, a test of simple sentence reading, and a test of pseudoword reading. The two phonetic tasks of main interest were 1) a test of phoneme synthesis and 2) a test of phoneme deletion. In this task the child was given three isolated segments and asked to produce a word or syllable. There were eight real words followed by four pronounceable non-words in the task. The words were chosen to represent a difficulty ordering beginning with the two segment word see and ending with the four segment word with a consonant cluster stop.

The phoneme analysis task was one adopted from Bruce and Rosner in which the subject was required to produce a transformation of a word spoken by the experimenter. There were two tests for each word, one requiring deletion of the initial segment and one requiring deletion of the final segment. The subject was then asked to produce cat without the /t/ and and then without the /k/. In the deletion task it was always the first segment or the final segment that was deleted.

Subjects. Subjects were 99 students from three classrooms and two different Pittsburgh area schools. Seventeen of these children were a classroom of repeaters who had not achieved satisfactory progress in learning to read in the previous year. The remaining 82 subjects were three classrooms of first graders. These 82 subjects included a direct code group who were taught by a direct code instruction program developed by Beck and two basal groups who were taught in classroom with widely used basal readers. The two basal groups were very different in entering ability, with one group beginning with a reading readiness workbook while the other group began the first year of instruction with the basal reader. Their classroom assignment was based on end-of-year reading readiness tests. We refer to these groups as the readiness group and the rockets group respectively. The direct code group was intermediate to the two basal groups in entering ability. They were essentially more variable than were the two basal groups.

The interest in the three different groups of subjects was in the method of instruction. Notice that one of these groups, the direct code group, was taught reading by a direct letter phoneme correspondence method. The other groups were not taught be direct grapheme-phoneme correspondence. The question of course is whether a group whose instruction depends upon grapheme phoneme correspondences needs to demonstrate knowledge of phoneme synthesis prior to instruction more than does a group with basal instruction. In other words this is an opportunity to test the assumption that the kind of prereading knowledge a child needs depends upon the way beginning reading will be taught. The direct code group was taught by the NRS system (Beck and Mitroff) and, importantly, it requires explicit blending as part of the reading curriculum. Not phoneme blending, but blending based on visual

presentation of letters and spoken word responses by the child. (In this program, children read only real words, never nonwords.)

Testing schedule. Four tests were given throughout the school year. The first test, T0, was actually a pretest given during the first week of September prior to any reading instruction. The next text, T1, was about the fourth week of October; T2 was in mid-January; T3 the end of April. At the end of the year, a wide range achievement test was given by the experimenter to each subject.

Results

Phoneme synthesis. One way to look at the synthesis data is in terms of the percentage achieving criterion. Criterion performance for synthesis was 9 or or more correct out of 12, assuring correct performance on at least one pseudoword. The percentage of subjects reaching criterion on each test point is shown in Figure 1. Figure 1 shows several significant things. Few children achieved criterion prior to the beginning of instruction. Of 82 children beginning first grade, only five performed correctly on at least nine of twelve test items. A second fact is that reaching criterion was related to the child's instruction group. All direct code children achieved criterion while three rockets, (12%) and nine readiness children (29%) failed to achieve criterion, even at the final testing at the end of April. A third interesting result is the relatively slow acquisition rate of the direct code group compared with the rockets group. After eight weeks, 42% of the rockets had reached criterion on the synthesis task. By contrast, only 24% of the direct code group had reached criterion. This is especially interesting for two reasons. First, the direct code group exceeded the rockets group by the third test point, roughly the 19th week of school. Second, during the seven weeks prior to this test

point, the direct code group had been taught not only eleven grapheme-phoneme correspondences, but also the blending routine of the NRS instruction program. In other words, these children are required to synthesize words from isolated letters. However, they are not yet doing such synthesis to isolated phonemes.

Deletion. The percentage of subjects reaching criterion in the deletion task at each test point is shown in Figure 2. Generally speaking, the ability to perform deletion was very low prior to the beginning of instruction. The few subjects who did reach criterion, mainly from the rockets, already were able to show some reading ability prior to instruction. By the end of the school year, about half the subjects overall had reached criterion. What is especially striking, however, is that this task, more than any other, showed differences among the groups. Among the rockets most subjects achieved criterion and the mean correct was about 13 out of 16. The direct code group also did fairly well, although not quite as well as the rockets. Fifty-five percent reached criterion and the mean correct was around 10. The readiness group, by comparison, did quite poorly. Only about 26% achieved the criterion by the end of the school year. Also striking are the data from the group of repeaters; despite the fact that this was their second year of reading instruction, only two of them were able to reach deletion criterion by the end of the year.

The Relationship Between Reading and Phonetic Knowledge

A central interest, of course, is the relationship between the child's reading ability and his performance on these tasks of phoneme synthesis and analysis. Let's consider first the fifty-seven basal subjects, combining the slower reading group (reading readiness), and the higher ability group (rockets). The best predictor of year-end

reading achievement for this group is the deletion task, especially deletion measured at T2 and T3, that is, later in the school year. Early, prior to instruction at point T0 and also at T1 synthesis was a good predictor of year-end reading achievement.

One way to see the predictive value of deletion is in a multiple regression analysis in which each of the eight phonetic tests was entered as a predictor variable along with reading readiness scores. In this analysis, the last three deletion test scores each contributed significant variance with the three combined accounting for 77% of the variance in year-end word reading. Since there was some unique variance contributed by each successive deletion task, we can suggest that the deletion tasks are not necessarily tapping the same abilities at each test point. This, in fact, is an important point in our general theoretical framework. The abilities tapped by these phonetic tasks are not static entities, but in fact are modified by the processes of learning to read. We had a second dependent measure in addition to end-of-year (WRAT), and that was curriculum progress. We were able to measure the point in the curriculum in the basal reader that the child had progressed to. Overall, the pattern of correlations can be summarized this way: prior to any instruction, phoneme synthesis is a better predictor of end-of-year reading achievement and reading progress. However, later on after instruction, performance on deletion is a better predictor.

The direct code group presents a different picture. For them, synthesis was never a very good predictor of end-of-year word reading. Deletion, on the other hand, was a fairly good predictor. At first glance, this might seem contradictory. The direct code group, after all, was a group taught by grapheme-phoneme correspondences and blending

was one of the things they were expected to do. However, the failure for the first synthesis to be a good predictor of year end reading achievement is quite sensible. After all, the direct code group was going to be taught by a method that, in a sense, included some of what the synthesis test measures. It is not a very good predictor of word reading because students are directly taught the relevant skill, thus eliminating the significance of individual variability.

Time Lag Data

An issue of central interest is what is causing what in the relationship between phonetic knowledge and learning to read. In the longitudinal study, because of the repeated testing procedure, we had reading measures at each test point that could be related to phonetic knowledge at each test point. The pseudoword reading measure taken at each test point could be related not only to a phonetic score at that test point but also to a phonetic score at a later test point and at the most recent test point. The general questions of interest are these: 1) What is the relationship between the test point at which the child first passed criterion on a phonetic test and his final WRAT performance? 2) How does pseudoword reading performance compare at test points before and after the child passed criterion?

When the data are examined in this way, two results are especially interesting. First, subjects who achieved criterion early did better on the WRAT than subjects who passed it late or not at all. In practical terms, the difference between a subject who passed synthesis at time T1 compared with time T2, some 11 weeks later, is almost one grade level by the end of the school year. The second fact of interest is that pseudoword reading performance went up at the time the subject achieved synthesis criterion. That is, on the test session prior to the

subject's achieving synthesis criterion, his reading of pseudowords was significantly lower compared with the point at which synthesis was achieved. Third, this last pattern held both for the direct code group and the basal groups. That is, although the direct code group's end-of-year reading achievement was not so well predicted by synthesis as was the basal group's, their progress at reading pseudowords was in lock step with their progress in synthesis.

We can take a closer look at the relationship between pseudoword reading and phonetic synthesis and phonetic deletion by means of time lag correlations. In particular, we asked whether performance on a phonetic task at time n correlated more highly with reading at time n+1 or time n-1 (In this case, time refers to test time). If the correlation with time n+1 reading is higher than with time n-1 reading, we can infer that phonetic knowledge enables reading more than reading enables phonetic knowledge. These time lag correlations are especially meaningful when the correlation between reading and phonetic performance at the same test point is controlled for. We have such correlations for synthesis and deletion shown in Figure 3. In Figure 3 arrows connect tests at successive test points to show partial correlations, i.e., with the same time correlations partialled out. (Symbols S, D, and R refer respectively to synthesis, deletion, and pseudoword reading.) The partial correlation can be interpreted as showing whether there is a significant future predictive ability in a test after its same time correlation is removed. Darkened arrows indicate significant correlations.

The results of the partial correlation time lag analysis support the following interpretation: For both basal and direct code groups, synthesis progress precedes reading progress more than vice versa. For basal subjects the largest predictive relation is from test 1 to test 2, while for the direct code group it is from test 2 to test 3. The correlation of .57 is fairly large, considering it partials out the correlation between the same two tests at an earlier time.

For deletion, the interpretation is a bit different. For the basal group, reading and deletion are mutually predictive. Early progress in reading leads to later progress in phoneme deletion which in turn leads to still later progress in reading. For the direct code group, there is only one significant relationship, namely, that reading precedes phoneme deletion.

When all the various correlational data of Perfetti, Beck and Hughes are considered, the general conclusion seems to be as follows. Regardless of instructional method, phoneme synthesis ability is necessary for reading to occur but it is not sufficient. Phoneme deletion is sufficient for reading to occur, but not necessary. Thus, the ability of phoneme analysis is one that is followed by early skill in reading, whereas the ability of phoneme synthesis is one that precedes early skill in reading.

Task Models

We will briefly refer to what we see as the differences between the phoneme analysis and the phoneme synthesis tasks that are relevant for early reading. In the Perfetti, Beck, and Hughes longitudinal study, we have constructed processing models to describe the performance both of phoneme synthesis and phoneme analysis. And we have used these models to describe the developmental changes that occur during the child's

first year. In other words, we have models for each of the different test points in the data.

Synthesis. First we consider the synthesis task. Developmental trends in the synthesis task can be captured by observing that over the course of the year, the child's responses to the segments became increasingly phonetically constrained. For example, when we look at the errors the children made, about 18% of the children's responses at the first test point suggest they use no phonetic segmentation strategy at all. An example of this is the child who, when given the segments K-A-N responded with the word telephone. Children also at the first test often responded with semantically related words rather than the word itself, e.g., D-O-G producing the word gone. This second kind of error is especially interesting because it has to mean that the child did the synthesis. He converted D-O-G into dog and then gave an association, dog gone. The percentage of these responses were greatly reduced over the course of the year, falling from 11% at the pretest to 0% by T3. Over the three testing points children's errors increasingly were phonemically constrained. That is, the child used the phonemes that he was given and produced a word that appeared to result from trying to match the phonemes to something in the lexicon. It's interesting that children became increasingly willing to relax lexical criteria in order to satisfy segmental constraints. Although children were told that the targets were real words, the percentage of nonword responses increased from 15% to 27% across the first three tests. This is evidence that the children learned that the segments themselves were critical to operate on and that this was better than trying to guess words.

In general, there are two developments in summarizing the way the children performed phoneme synthesis. The first is that children developed phonetic strategies for the task in case they did not have them in the beginning. Many children had them in the beginning, but those who did not learned essentially to develop a phonetic strategy by which the segments themselves were stored in memory and synthesized to produce something. The second result is that when children had a phonetic strategy they became increasingly able to use all the segments to produce a response. That is, errors that were based on only one or two of the segments sharply decreased over the course of the year.

Deletion. The development of performance in the deletion task was reflective of a shift from lexical holistical strategies to more analytic strategies over the course of the year. For example, at the beginning of the year, given the word cat and instructed to say cat without the /k/ or cat without the /t/, common responses were rhymes such as hat. Over the course of the year, such responses were greatly reduced and errors instead reflected segmental strategies. That is, word associations were completely eliminated in the child's response and his errors tended to always reflect stripping some segment from the stimulus.

We should say something about the possibility of spelling strategies in these tasks. Our analysis suggests that while subjects sometimes named letters instead of producing words in both synthesis and analysis, there was little evidence that they used spelling vs. phonetic strategies to solve the task. However, we do believe that both written and spoken components of words became more available to the child as he became a more skilled reader.

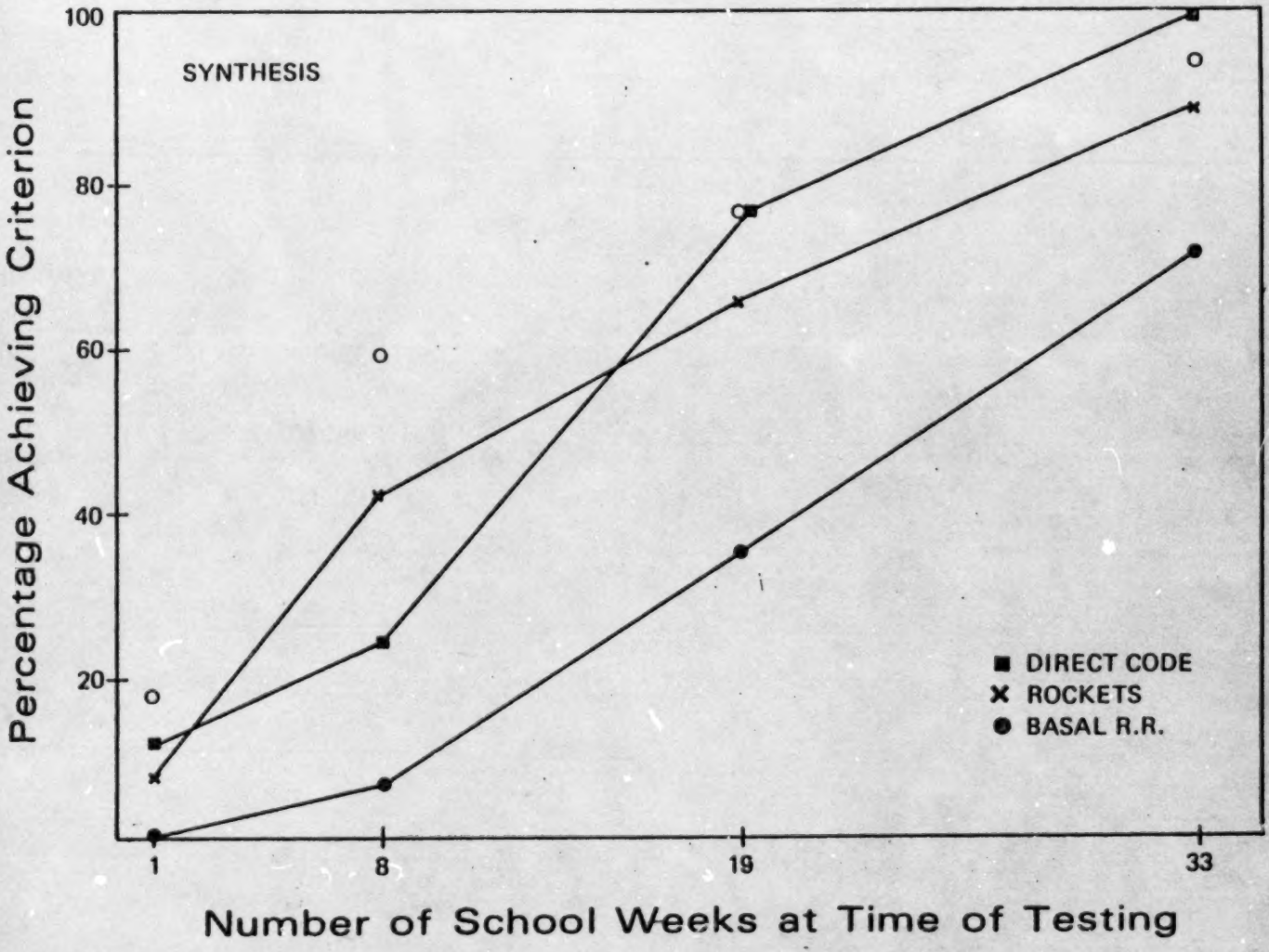
Learning to Read and Phonetic Knowledge: Conclusion

In conclusion, we wish to suggest, as the title indicates, that phonetic knowledge is important for reading and reading is important for phonetic knowledge. The details of this relationship depend on the kind of phonetic knowledge involved. In part, this is because reading acquisition can begin in a number of ways. As Phil Gough points out, beginning reading can be partly an associative process in which connections are made between whole words and their previously learned language equivalents. Whether a child begins by learning more holistically or more analytically, eventually the child will learn to respond to letter strings somewhat more analytically, if he really learns to read. As he learns to respond more analytically to letter strings, noticing things about letter phoneme correspondences and so on, his previously unused knowledge of speech segments becomes increasingly accessible. It is simply part of a process of becoming aware of the constituents of words. In fact, it is likely that letters are more salient as constituents to the child and phonemes are less salient as constituents (cf, Ehri). Thus, a task which depends upon the child analyzing a spoken word into its constituents can be expected to benefit from an earlier stage of reading progress, which is what we have found. Meanwhile, however, progress in learning to read, that is, learning to decode, is going to be predictable to some extent by the child's appreciation that phonemes can be put together to produce syllable and word units in the language. This is going to be a part of his early reading experience and, as we have found, it is closely related to ability to synthesize phonemes.

With respect to the teaching of reading, we have just a few observations. First there is not in the longitudinal data the close match between the form of instruction and the type of phonetic knowledge related to reading. For both basal instruction and direct code instruction, phoneme synthesis preceded rather than followed the ability to read pseudowords. For both basal instruction and direct code instruction the ability to read pseudowords preceded the ability to perform phoneme analysis. The one interesting difference between basal instruction and direct code instruction was this: Children undergoing basal instruction were more likely to be high reading achievers at the end of the year if they were good at phoneme synthesis at the beginning of the year. For direct code subjects, being good at synthesis was not so important because it is the kind of skill that they were going to be directly taught. The other hint of an interesting difference is that the basal groups continued to show reading improvement following their ability to do phoneme analysis. In other words, for the basal groups there was evidence that further progress in reading followed upon becoming good at deletion and this may not true for the direct code group. Again, the implication may be that a group that is not going to be taught phonemic skills as part of their reading will have some aspects of their early achievement more dependent on these skills.

Finally, we note that we have avoided the word "prerequisite." The concept of a prerequisite to learning to read is rather slippery, to say the least. (See Lesgold and Curtis for some useful ideas on this point.) We instead insist on saying that the relationship between phonetic knowledge and early reading is one of <u>mutual facilitation</u> based on the intimate relationship between spoken and written language. Anything more specific than this, as we have argued, depends on careful

attention to specific components both of reading and of phonetic knowledge.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40
20
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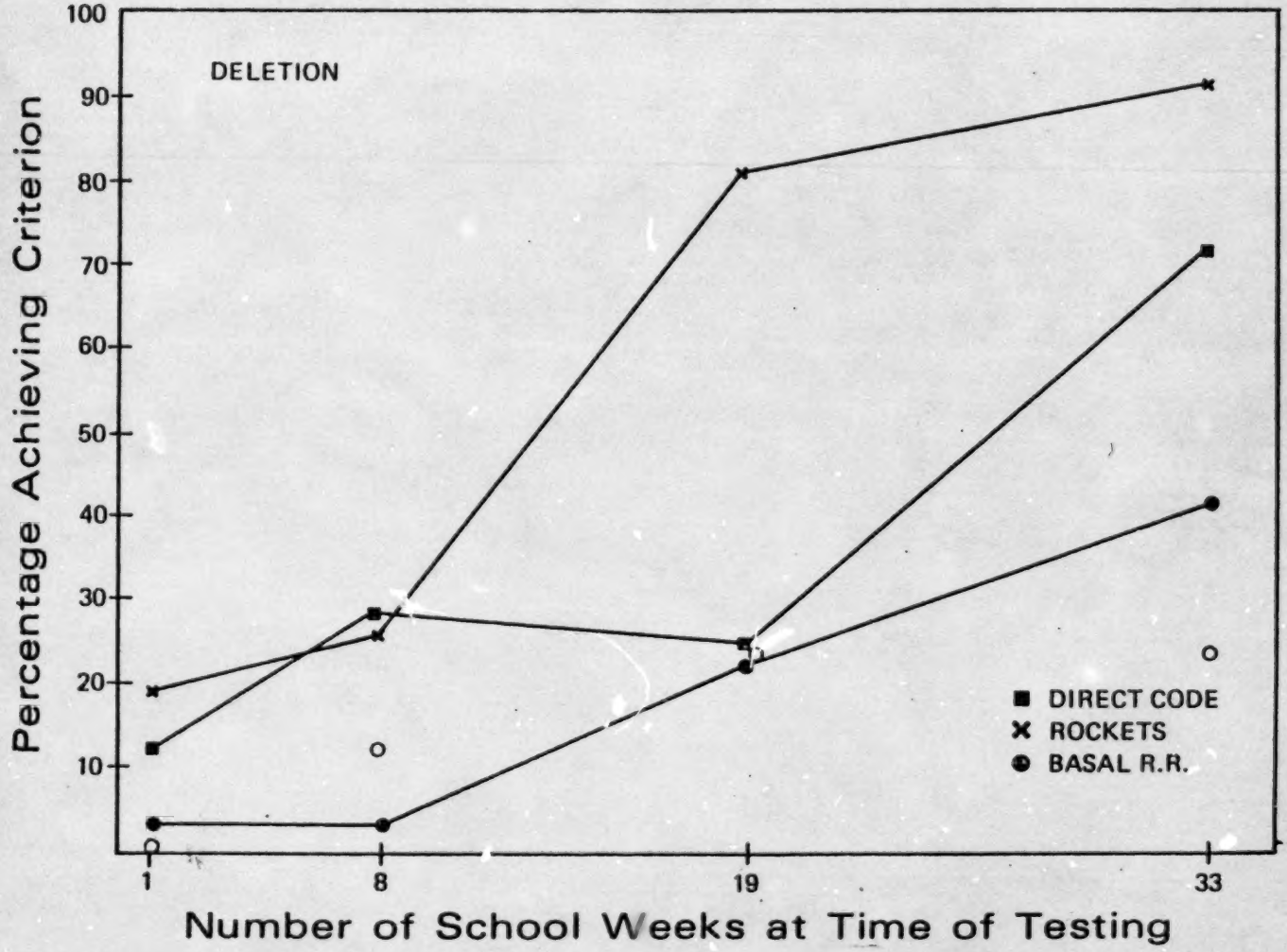
8
19
33
Number of School Weeks at Time of Testing
DIRECT CODE
ROCKETS
BASAL R.R.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Percentage Achieving Criterion
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90
80
70
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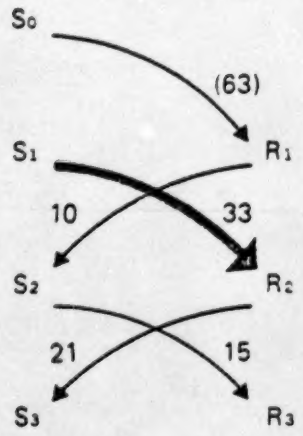
30
20
10
1
8
19
33
Number of School Weeks at Time of Testing
DIRECT CODE
ROCKETS
BASAL R.R.



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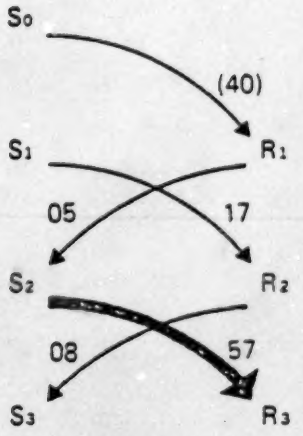

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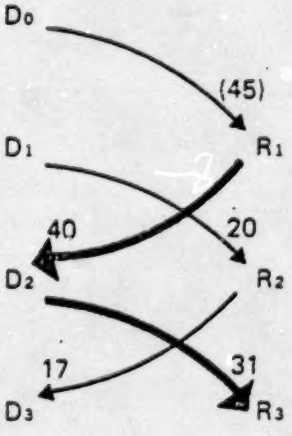

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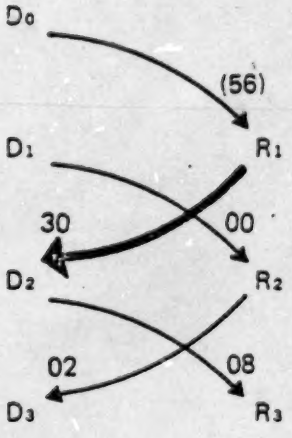

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